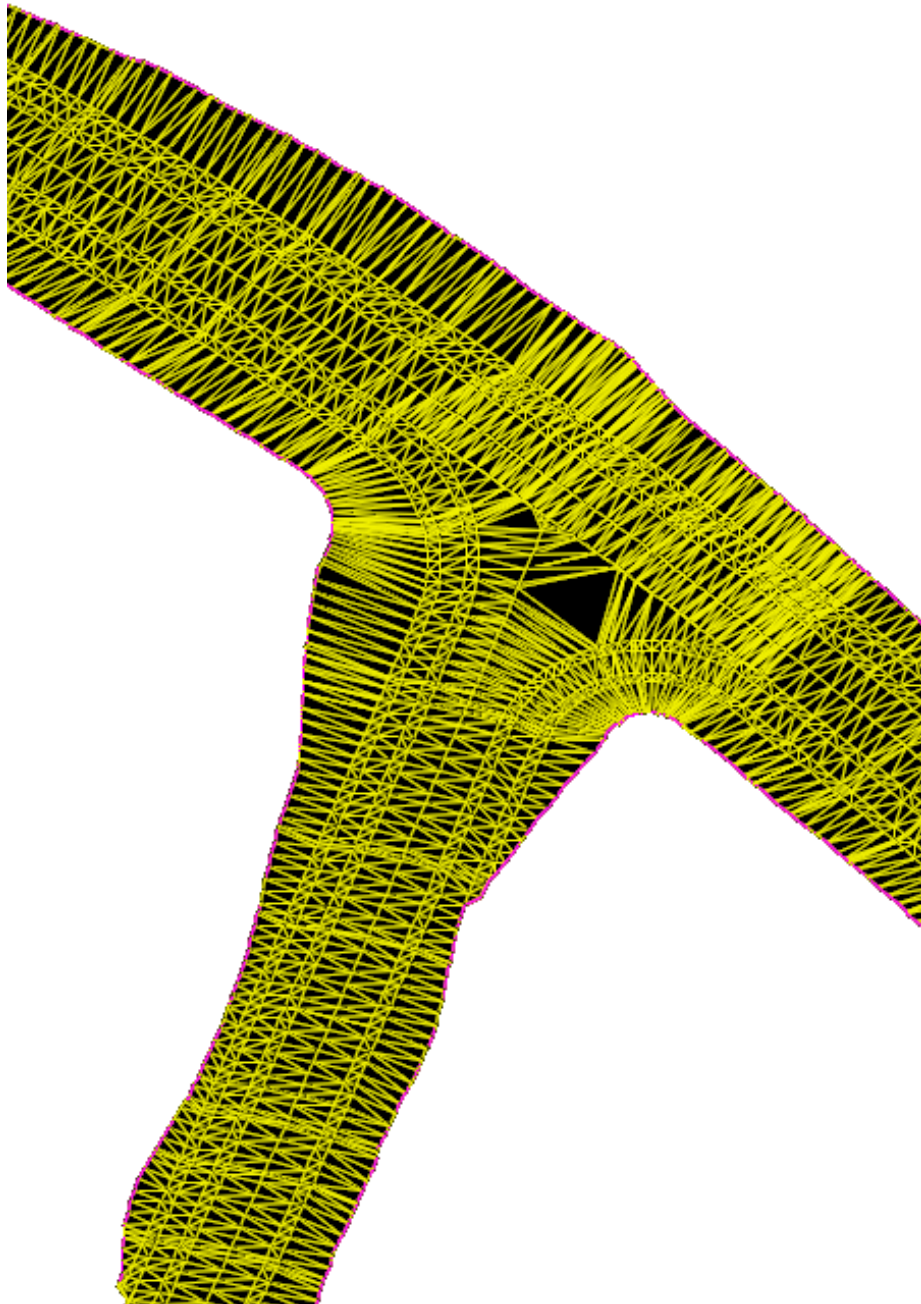# GeoPak Road 2
Advance Terrain Modeling

19.1 Terrain Model Create

The Terrain Model Create tool group contains tools to create a terrain model from graphical elements, ASCII files, point clouds, LandXML, and importing from various Bentley Civil products. Tools are also supported to merge together two or more models, and to clip models.

Select in the Toolbox	Description
Create from File	Creates a terrain model by importing from an external file. Numerous file formats are supported supported such as USGS DEM, DTED, Lidar (*.las), and native products (InRoads, GEOPAK, and MX).
Create Terrain Model by Graphical Filter	An automated way of storing search settings for graphic elements to automate Create Terrain Model by Elements. Uses the settings stored by Graphical Filter Manager to create the terrain.
Create from Elements	Creates a terrain model from 3D graphical elements.
Create Complex Terrain Model	Creates a new Complex terrain model by merging/appending multiple terrain models.
Create Clipped Terrain Model	Creates a terrain model by clipping an existing terrain model and providing an optional horizontal or vertical offset.
Create Corridor Alternate Surface	Creates a terrain model from user-specified points in a corridor model along any given path.

| Select in the Toolbox	Description
Create Terrain Model from ASCII File	Creates a terrain model by importing from an ASCII file type using a user customizable format files.
Create from Point Cloud	Creates a terrain model from MicroStation Point Cloud data.
Create Delta Terrain Model	Creates a new terrain model by the difference between 2 terrain models or a terrain model and a plane (elevation).
Create Terrain by Text Interpolation	Creates a terrain model from 2D graphics which also contain an elevation label.

19.1.1 **Edit Terrain Model**

These editing commands are for a terrain model that has no graphic elements with rules. For example, importing terrain models from other formats without creating features. The commands allow limited editing without returning to the source and importing features. If you need additional editing capabilities then import the original source and use the other editing methods.

| Settings	Description
Delete Vertex	deletes the specified vertex, then re-triangulates the terrain model without it. Note you cannot select a vertex that is on the edge of the terrain model (boundary).
Delete Edge Triangle	determines the triangle from the user-defined edge, then deletes the triangle from the model and the boundary is updated accordingly.
Swap Line	changes the common side of two triangles.
Insert Vertex	inserts a vertex inside or outside of the terrain model. If the point is inside the model, an option is supported to use the elevation of the face (interpolated from the triangle vertices) as the elevation.
Move Vertex	moves the vertex of a triangle. A toggle in the tool settings enables the user to use the elevation of the original vertex.
Delete Triangles by Line	deletes all triangles which intersect the line (defined by two data points within the tool) and the boundary is updated accordingly.

19.2 Create Corridor Alternate Surfaces

The Create Corridor Alternate Surface tool creates a terrain model from user-specified points in a corridor model along any given path. For example, it may be desirable to obtain a surface for the bottom of the aggregate lift in a pavement layer structure. In this example, each point along the bottom of aggregate path would have set the name to be used for that particular surface. It is important to use the same name for each point that is to be part of the aggregate surface path. All points with an Alternate Surface name specified are added to an alternate surface. Specify the alternate surface name in the Corridor Modeling > Create Template > Edit Point > Point Properties dialog. The options are to key in a new name or select from a previously keyed in name.
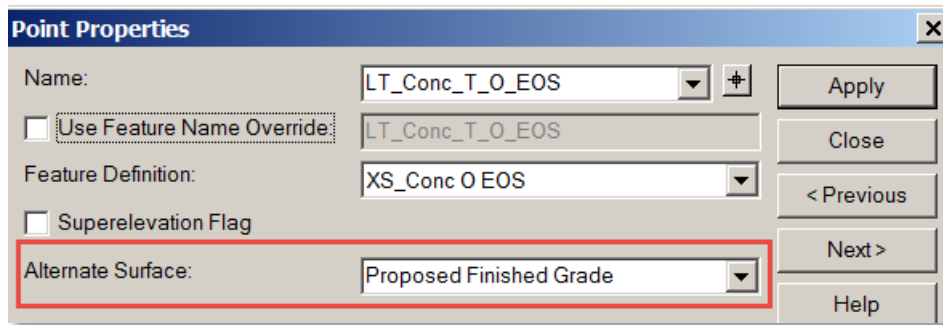

 All alternate surfaces (and corresponding points) for a specified template can be viewed in the listing for the active template.

The software scans the template points for Alternate surface(s). If one is found, a terrain model is created. It copies all breaks, boundaries, etc. into the alternate surface and assigns template points feature definition from the corresponding point in the Template. The resultant terrain model is named with the alternate surface name prepended by the corridor name.
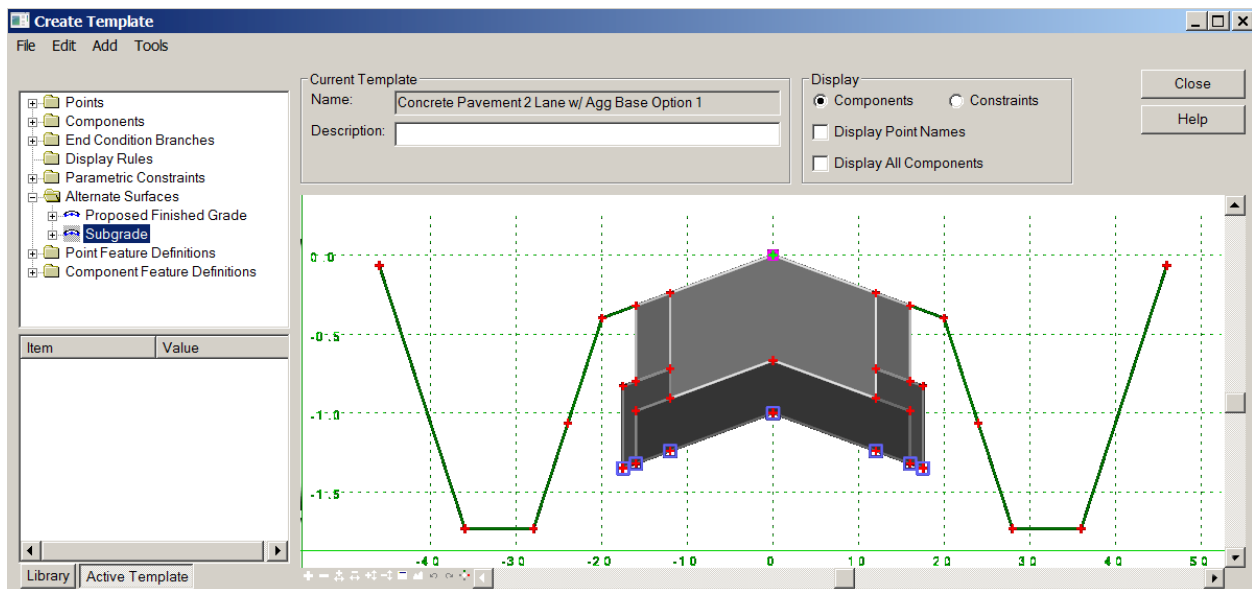
Project Explorer

The created alternate surfaces are listed under Terrain Models within the Project Explorer.
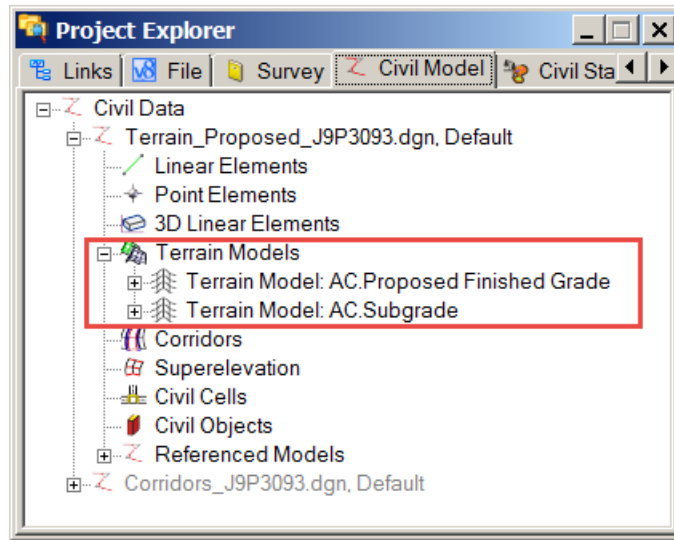

 Right click on any terrain model to open the context sensitive menu and select Properties to view properties and change display settings, etc.

Element Info

Workflow: To Create Alternate Surfaces

Select the Create Alternate Surfaces tool and follow the heads-up prompt to select the corridor. The processing progress bar is displayed at the bottom of the screen.

1. Open the Project Manager to view the created terrain models. Use Properties to view attributes or change display settings. Properties can also be accessed by graphically selecting any terrain model, right click and select Properties (Element Information).
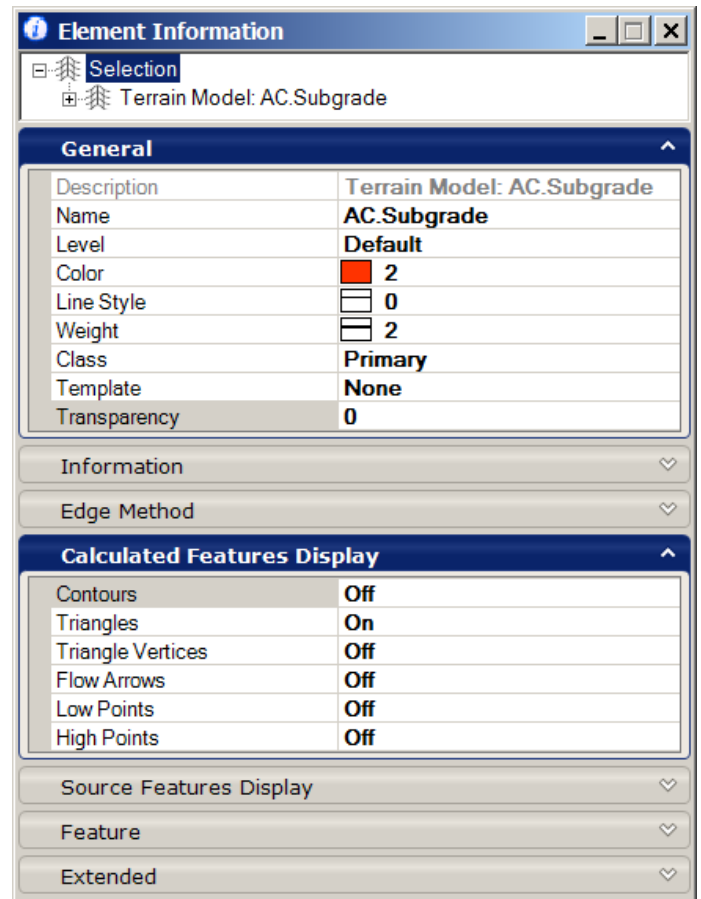
19.3 Group Exercise: Create Terrain by Alternate Surface

1) Open **Perry\J9P3093\data\Corridors_J9P3093.dgn**

2) Review Project setup. AC is mainline Corridor, TG is side road Corridor and two linear templates are in the radius return area at the intersection of AC & TG.

3) Review Template Drop on mainline **AC** Corridor.

    a. Use the Active Template Tab and review the Alternate Surfaces for the Template.

4) Create **Terrain_Proposed_J9P3093.dgn** using the **i_project_3d_PowerGeoPak.dgn** as the seed file.

5) Reference in **Corridors_J9P3093.dgn (Default 2D View)** and the **Terrain_Existing_J9P3093.dgn**

    a. Set the Terrain Model **J9P3093** active

        Note: Creating a Terrain Model with an Alternate Surfaces will work with any Design Stage.

6) Select the **Task > Civil Tools > Terrain Model > Create Corridor Alternate Surfaces** tool and select the "AC" Corridor, and wait.

7) Detach all reference files and rotate the view, select "**Yes**" below to break the rules back to the reference files.
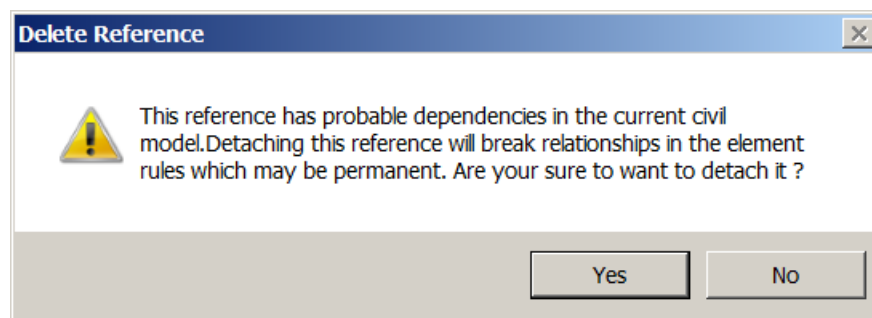
8) There are two Alternate Surfaces created, set the **AC.Proposed Finished Grade** Terrain Model to have a Feature Definition of **Design Triangles**

9) Rotate the view to see the second terrain model **AC.Subgrade**

10) Use the Project Explorer Civil Model Tab to delete the **AC.Subgrade** terrain model.

11) Rotate the view to top and select fit view

12) Even though the reference files were detached, the terrain model AC still has rules applied. Use terrain model heads up tools and drop the rules to the AC terrain model.

13) Select **Task > Civil Tools > Terrain Model > Edit Terrain Model** tool.
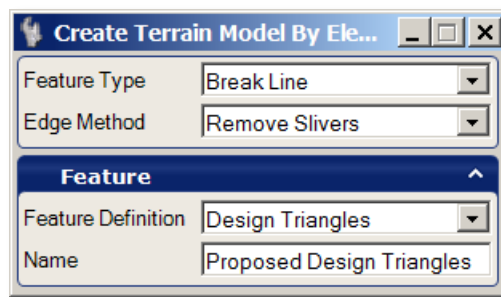   a. Edit the Terrain model.

   Notes:
   - Alternate Surface can only process one corridor at a time

   - The **Create Corridor Alternate Surfaces** tool works with Referenced Corridors, in other words you don't need to be in the Corridors file for the tool to work.

   - With Alternate Surfaces to get the End Conditions to draw, the target of the End Conditions, typically existing ground must be present and active.

   - The Terrain Edit Tools can modify the newly created Terrain Models from the Alternate Surfaces Tool only after the rules have been dropped.

   - Alternate Surfaces **do** have rules back to the original Corridor and template.

   - When you remove the Rules from the Terrain Model you break the link to the Corridor.

19.4 Create from Elements

The **Create From Elements** tool creates a terrain model from 3D graphical elements that is ruled. Ruled Terrains update dynamically if the source elements are changed. Each element or group of elements of a terrain feature type can be selected individually or via selection set. This tool is useful if the elements do not have consistency symbology or attributes (where the Create From Graphical Filter Group tool may be a better option). After the terrain model is created from the first grouping of elements, the software prompts to append another terrain feature (by defining another selection set of elements) or to create another terrain model. The models are named Terrain Model (Element), Terrain Model (Element) 1, and etcetera.

Workflow with Predefined selection set:

1. Define a selection set of all elements of a type (example all break lines) to be made into a terrain model.
2. Select the tool. A prompt is displayed indicating how many elements are in the selection set. Data point to accept.
3. At the prompt set the type of elements being extracted (example, break lines, points, voids).
4. Enter edge options.
5. Terrain is created and the Add or Remove Feature tool is automatically opened, so you can append to the newly created TM.

Workflow Without Predefined selection set:

1. Select the tool.
2. When prompted, select the first element to be included. Continue selecting elements, then reset to complete the prompt and move to the next step.
3. Set the type of elements being extracted (example, break lines, points, voids).
4. Enter edge options.
5. Data point to accept.

Terrain model is created.

19.4.1 **Create Terrain Model Boundary**

The Create Terrain Boundary option allows the extraction of implied or stored boundaries from terrains with the ability to edit / rule the boundary. Once a boundary is added to a terrain as the edge method, the other methods of max side length and slivers are not available as they are overruled by the explicit boundary. A boundary added using this new tool can be removed using the Remove Terrain Model Boundary Tool.

The Create Terrain Boundary includes 3 methods

1. **Extract Graphic** - extracts the current boundary for the triangulation to an editable 3D linestring
2. **Add Boundary** - extracts the current boundary for the triangulation as an explicit boundary in the terrain element - ie locked boundary
3. **Add Ruled Boundary** - extracts the current boundary for the current triangulation to an editable ruled draped boundary

19.4.2 **Export to File**

With data collection methods underlying Terrain Models (TM) increasing in detail and size the resulting TMs need to be stored and exported in an efficient manner making data transfer possible across a variety of Infrastructure and Mapping workflows. As part of these workflows a common requirement is to store data external from the primary storage for backup or transfer data to other applications (even to older versions of the Bentley Civil applications). Use this command to identify requirements for export of Civil TM's to external files.

The TM can be exported to :

- GEOPAK (TIN)
- InRoads (DTM)
- MX (FIL)
- LandXML version 1.2

Note: Additional prompts are required when exporting to MX or LandXML formats.

Workflow

1. Start the command.
2. Select terrain.
3. Select output type.
4. Complete additional prompts for MX or LandXML formats.
5. In the File Manager, enter the name of the exported file to be created.
6. Click Save.

19.5 Group Exercise: Create Terrain by Mesh

1) Open **Perry\J9P3093\data\Corridors_J9P3093.dgn**

2) In the 2D Default view, change the Design Stage to **Final – Top Mesh** for all Linear Templates and Corridors.

3) Open **Perry\J9P3093\data\Terrain_Proposed_J9P3093.dgn**

4) Reference in **Corridors_J9P3093.dgn (Default 2D View).**
   a. If needed rotate the view to "**Top**"

   Note: If the Corridors 3D view is not automatically referenced in, process a function in the master file. For Example reference in the terrain existing file and make the existing ground terrain model active. For whatever reason, sometimes when a file is reference in, the master file does not always recognize the reference file immediately. This behavior can be verified in the Civil Model tab.

5) Select the **Top Mesh** elements using the **Element Section** tool using the Control key to select the **four** Mesh surfaces.
   a. Verify that only four items are in the Selection Set.

6) Select the **Task > Civil Tools > Terrain Model > Create from Elements** tool and choose the following:

Feature Type:	Break Line
Edge Method:	Remove Sliver
Feature Definition:	Design Triangles
Name:	Design Triangles from Mesh

7) Detach both reference files and rotate the view.

8) Using the **Terrain Model** heads-up tools remove the **Rules** to the terrain model

9) Select **Task > Civil Tools > Terrain Model > Edit Terrain Model** tool.

10) Remove the false external triangle legs.

11) Using the **Terrain Model** heads-up tools select the terrain model **Export** tool and select Land XML.

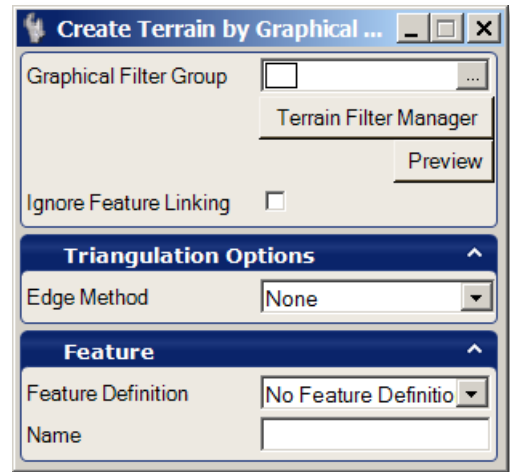|	
Select Terrain:	Design Triangles from Mesh
Export Format:	Land XML (.xml)
Project Name:	J9P3093
Project Description:	AC Corridor Proposed Terrain
Export Options:	Export Triangles Only

Notes:

- The **Create from Elements** tool works with Referenced Corridors, in other words you don't need to be in the file of the 3D elements for the tool to work.

- In the **Create from Elements** tool the Feature Type determines how much editing you can do to the terrain model. If **Break Lines** are used, certain triangle legs will not be editable, but if you use a Feature Type of **Spots** they will.

- Mesh Terrains **do** have rules back to the original Corridor and template.

- When you remove the Rules from the Terrain Model you break the link to the Corridor.

19.6 Terrain by Graphical Filter

Data may be provided for consumption into the terrain model in a variety of formats including raw graphical elements both 2D and 3D. For the Create Terrain by Graphical Filter, the elements must be 3D. The tool is useful when the source data has consistent (standardized) element symbology. Rather than defining the element symbology for each terrain feature each time a terrain model is created, the information can be stored in a filter group. Numerous groups can be stored in a dgnlib, so the user merely selects the appropriate group, based on the type of features and associated symbology. If none of the groups are applicable, a new filter group can easily be created.

The advantage of the Create Terrain by Graphical Filter tool is that numerous terrain features can be imported simultaneously; the user does not have to select each feature individually, as with the Create Terrain by Elements tool. However, there must be consistency in the source data to utilize this tool.

Settings	Description
Append to Terrain	Toggle on if there is already a terrain model in the file (or referenced) and the data is to be added to the selected TM.
Graphical Filter Group	Select the filter group from the list. If no filter groups are defined in the file or dgnlibs, a prompt is displayed indicating there are none, and the Graphical Filter Manager dialog opens. Note one the filter group is created, the user is returned to the Create TM dialog.
Terrain Filter Manager	Opens the Terrain Filter Manager.
Preview	Click to highlight any element in the view that matches the filter.
Ignore Feature Linking	The Ignore Feature Linking option is an override to the Link to Terrain Features in the Terrain Filter Manager dialog. When toggled off, the setting in the Link to Terrain Features within each filter is utilized. When toggled on, the Link to Terrain Features setting within each filter is ignored and the terrain model is created unruled.

Workflow

1. Start command.
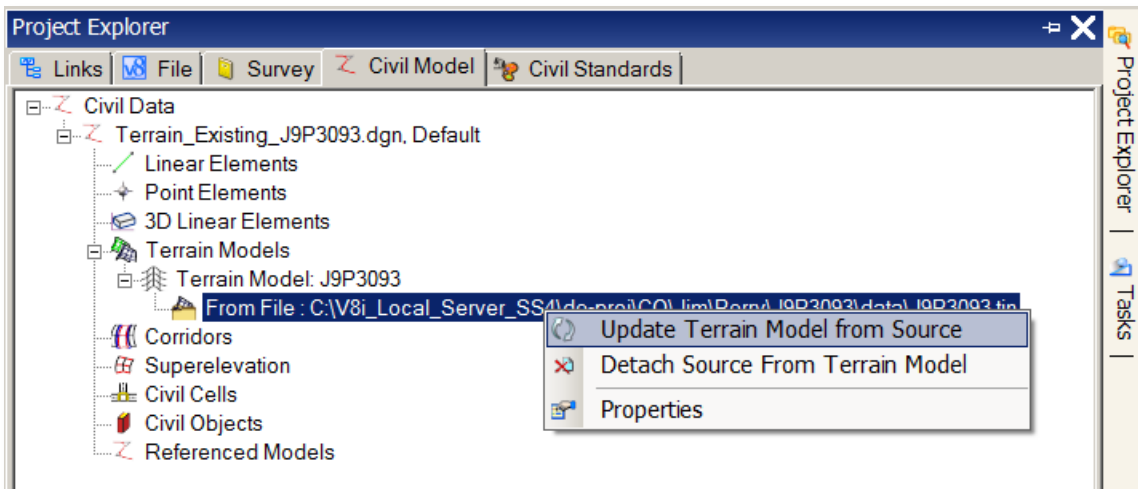2. Select the filter group.

Defined in a dgnlib library for ready use.

Or

1. Click Graphic Groups button to launch the Graphic Filter Manager and construct a custom filter group.
2. Datapoint to construct terrain from all visible elements in DGN and references.
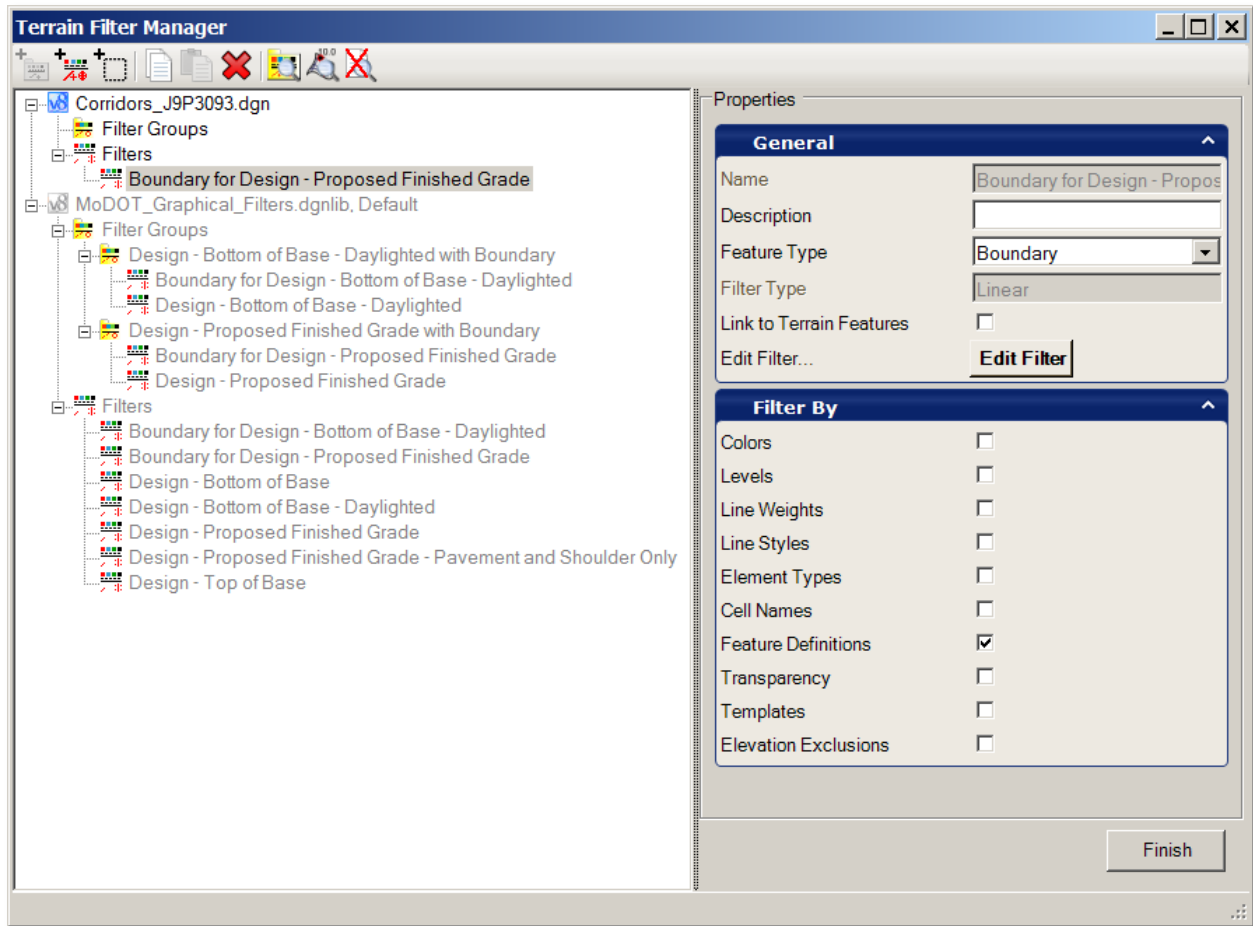
Update Terrain from Source

Terrains that have been created using graphical filters retain the creation rule on the Terrain. This is accessible in Project Explorer under the Civil Model > Terrain Models. Mouse selection of the Rule allows updating of the Terrain Source. The update reprocesses the rule and adds any additional graphical elements that have been added.

Graphical Filter Manager

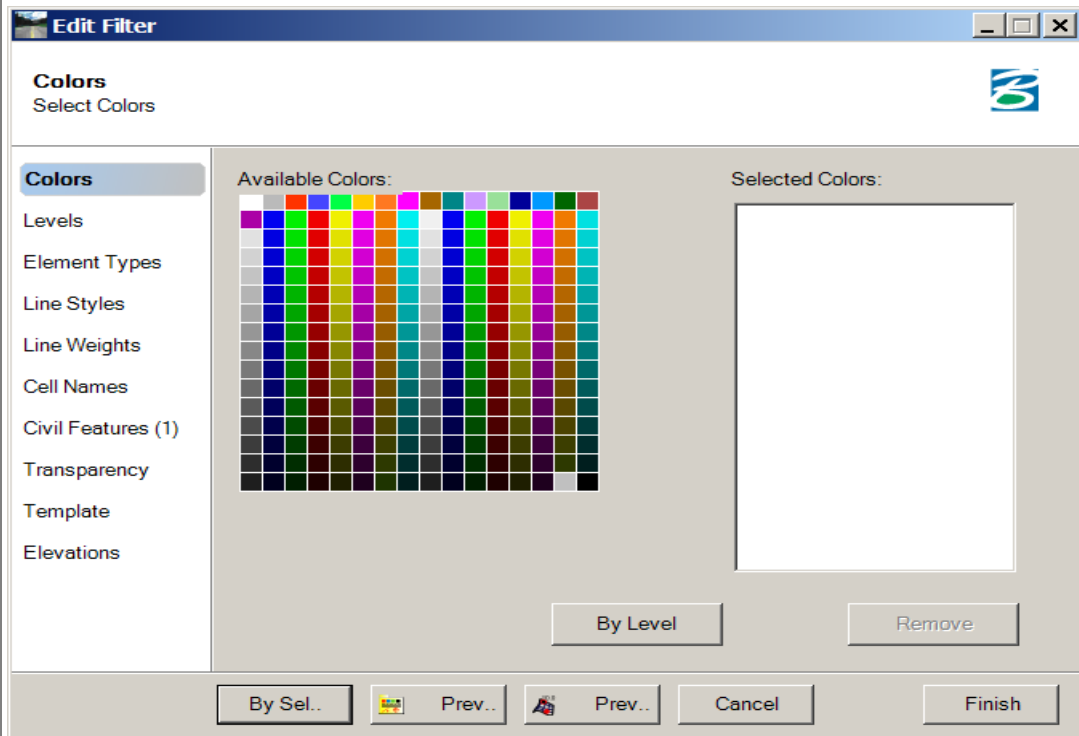| Prompt	User Action
Append to Terrain	Toggle on if there is already a terrain model in the file (or referenced) and the data is to be added to the selected TM.
Graphical Filter Group	Select the filter group from the list. If no filter groups are defined in the file or dgnlibs, a prompt is displayed indicating there are none, and the Graphical Filter Manager dialog opens. Note one the filter group is created, the user is returned to the Create TM dialog.
Graphical Filter Manager	Opens the Graphical Filter Manager.
Preview	Click to highlight any element in the view that matches the filter.
Terrain Features	Don't Link Feature Graphics The terrain model is created from the graphics but there is no association maintained with the graphic. Thus, if the graphic is edited later, the terrain model will not update. It will have to be regenerated. Use this option for faster performance. Link Graphic Features The terrain model is created and ruled to the graphic elements. Thus, edits to the graphic immediately update the terrain model. Using this option on large datasets takes a significantly longer time to build the terrain model. The DGN is scanned and the first 15,000 elements found are added to the rule that is attached to the terrain model that gets created. Changing one of these elements affects the terrain model. All other elements found in the DGN are added into the terrain model but not added to the rule. Changing one of these elements does not affect the terrain model. A warning displays in the Civil Message Center if the limit is reached.

Terrain Filter Manager

Settings	Description
Name	Brief, unique name to identify the filter.
Description	Optional description to further identify the filter (if the Name is insufficient).
Feature Type	Select the feature that corresponds to your data type. See also Features.
Filter Type	
Link to Terrain Features	Toggled off: The terrain model is created from the graphics but there is no association maintained with the graphic. Thus, if the graphic is edited later, the terrain model will not update. It will have to be regenerated. Use this option for faster performance. Toggled on:

|	
	The terrain model is created and ruled to the graphic elements. Thus, edits to the graphic immediately update the terrain model. Using this option on large datasets takes a significantly longer time to build the terrain model. The DGN is scanned and the first 15,000 elements found are added to the rule that is attached to the terrain model that gets created. Changing one of these elements affects the terrain model. All other elements found in the DGN are added into the terrain model but not added to the rule. Changing one of these elements does not affect the terrain model. A warning displays in the Civil Message Center if the limit is reached.
Edit Filter	Opens the Edit Filter dialog, wherein you set the parameters for the filter, i.e., levels, colors, civil features, etcetera. Set the parameters by clicking the category to the left, then selecting the parameters. Define a selection set, select the category, then click By Sel. The software auto-populates the fields, based on the elements in the selection set. Multiple selections are supported (Choose six colors or five levels, etcetera.) To view how many elements match the filter, click Preview. All elements in the view that fit the filter are highlighted. Once setting the parameters is complete, click Finish to close the editor and return to the Filter Manager dialog.
Filter By	The Filter By section displays at a glance which categories are being specified in the current filter. For example, if you used level and color to define the filter, the level and color items are toggled on, once the filter is finished. Refer to the MicroStation help topic for more information on levels, color, line weight, line style, and other element attributes.

19.7 Group Exercise: Create Terrain by Graphical Filter

The following steps will show the User how to create a Terrain Model of the Proposed Surface using the **Design - Proposed Finished Grade with Boundary** Graphic Filter. The Graphic Filter uses points along the entire proposed finished grade surface which includes but is not limited to side-slope conditions, top of pavement, top of shoulder, curb, etc. A Terrain Boundary will also be incorporated that includes the points that make up the Limits of Construction (LOC points).
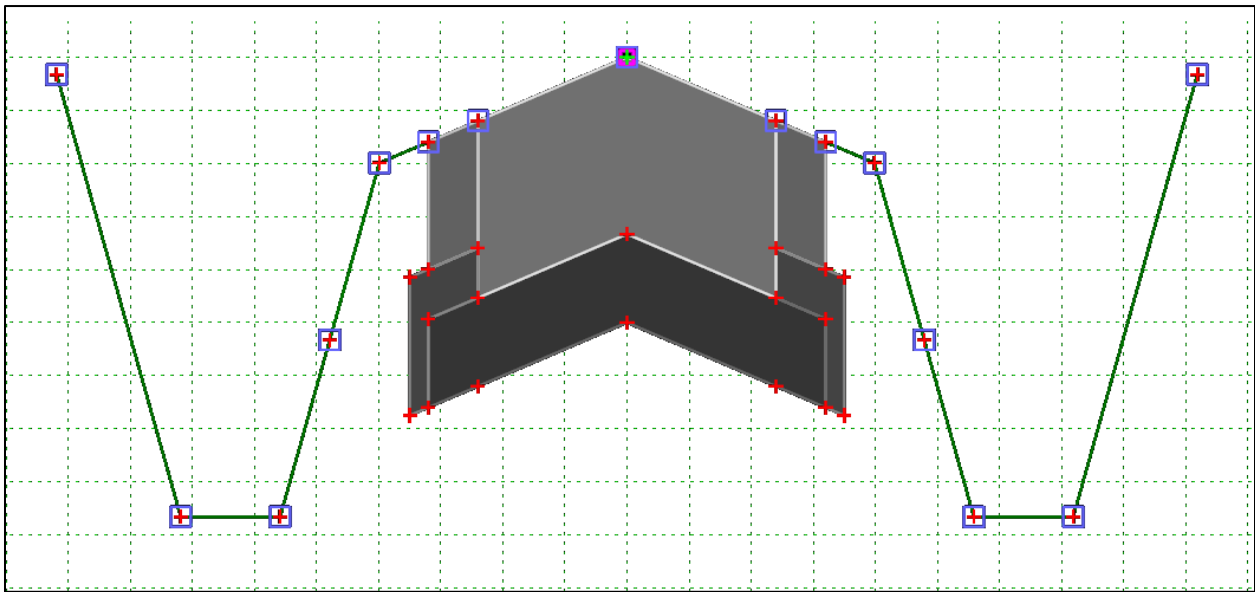
1) Open **Perry\J9P3093\data\Corridors_J9P3093.dgn**

2) Verify the Corridor Design Stage is set to a **Final-x 1** for the **RTEAC** and **TG** Corridors, and **1 - Design** for the **Radius Return** Linear Template Drops.

3) Open the **Terrain_Proposed_J9P3093.dgn**.
   a) If needed **Delete** and **Detach** everything in the file.

4) Reference in **Corridors_J9P3093.dgn (Default 2D View).**
   a. If needed rotate the view to "**Top**" and Fit the view.

5) Select **Task > Civil Tools > Terrain Model > Create Terrain by Graphic Filter** tool
    and choose the following:
    a. Graphical Filter Group: **Design - Proposed Finished Grade with Boundary**
        i.   Select the **Preview** Button
        ii. Linear Elements in the surface of the Model should highlight.
    b. Edge Method: **None**
    c. Feature Definition: **Design Triangles**
    d. Name: **Proposed Terrain from Graphic Filter**

    Note: When the tool is activated the Corridors 3D View is automatically referenced
    into the drawing.

6) Notice in the Project Explorer that the Filter Group and Individual Filters were copied
    over into the active file.

    > Project Explorer
        > Civil Standards
                > Terrain_Proposed_J9P3093.dgn
                    > Terrain Filters

7) Detach both references (2D and 3D) to the **Corridors_J9P3093.dgn**

8) (Optional Step) Select **Task > Civil Tools > Terrain Model > Edit Terrain Model** tool.
    a. Try and edit the Terrain model

   Note: The User will notice the Terrain is not editable.

9) Select **Task > Civil Tools > General Geometry > Remove Rules** tool.
    a. Remove the rule to the Terrain Model
    b. Using the **Edit Terrain Model** tools, modify the Terrain Model.

    Notes:

        • Graphic Filters **<u>do not</u>** have rules back to the original Corridor and
           template.

19.8 Individual Exercise: Create Terrain by Graphical Filter

The following steps will show the User how to create a Terrain Model of the Proposed Surface using the **Design – Bottom of Base with Boundary** Graphic Filter. The Graphic Filter uses points along the entire proposed finished grade surface which includes but is not limited to side-slope conditions, top of pavement, top of shoulder, curb, etc. A Terrain Boundary will also be incorporated that includes the points that make up the Limits of Construction (LOC points).
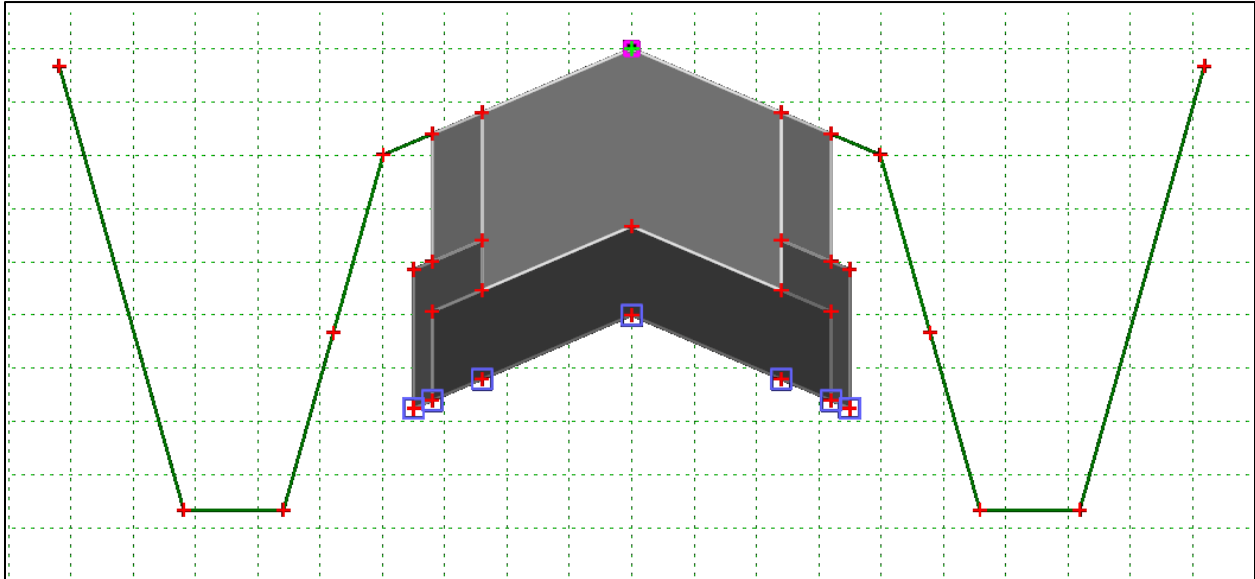
1) Open **Perry\J9P3093\data\Corridors_J9P3093.dgn**

2) Review Project setup.

3) Verify the Corridor Design Stage is set to a **Final - X 1** for the **RTEAC** and **TG** Corridors, and **1 - Design** for the **Radius Return** Linear Template Drops.

4) Create **Terrain_Proposed_J9P3093.dgn** using the **i_project_3d_PowerGeoPak.dgn** as the seed file.
   b) Reference in the **Corridors_J9P3093.dgn**, Default view.

5) Select **Task > Civil Tools > Terrain Model > Create Terrain by Graphic Filter** tool and choose the following:
   a. Graphical Filter Group: **Design - Proposed Finished Grade with Boundary**
      i. Select the **Preview** Button
      ii. Linear Elements in the surface of the Model should highlight.
   b. Edge Method: **None**
   c. Feature Definition: **Design Triangles**
   d. Name: **Proposed Terrain from Graphic Filter**

Note: When the tool is activated the Corridors 3D View is automatically referenced into the drawing.

6) Notice in the Project Explorer that the Filter Group and Individual Filters were copied over into the active file.

> Project Explorer
      > Civil Standards
            > Terrain_Proposed_J9P3093.dgn
                  > Terrain Filters

7) Detach both references (2D and 3D) to the **Corridors_J9P3093.dgn**

8) (Optional Step) Select **Task > Civil Tools > Terrain Model > Edit Terrain Model** tool.
    a. Try and edit the Terrain model

Note: The User will notice the Terrain is not editable.

9) Select **Task > Civil Tools > General Geometry > Remove Rules** tool.
    a. Remove the rule to the Terrain Model
    b. Using the **Edit Terrain Model** tools, modify the Terrain Model.

19.9 Group Exercise: Create Terrain by Linear Features

1) Open **Perry\J9P3093\data\Corridors_J9P3093.dgn**

2) Change the Design Stage to **Final - Linear Features** for all Linear Templates and Corridors.

3) Select the "**F6**" key to open the 3D view of the Model.

4) Close the **Default 2D** view and maximize the **3D** view.

5) In the **Reference** dialog turn off the display of all files.

6) If not already done, use the **Level Manager** turn off the levels of the non-surface linear elements

7) Place the remaining linear 3D elements into a MicroStation selection set.

8) Select the **Task > Civil Tools > Terrain Model > Create from Elements** tool and choose the following:

Feature Type:	Break Line
Edge Method:	Remove Slivers
Feature Definition:	Design Triangles
Name:	Design Triangles from Linear Features

9) Using the **Element Selection** Tool select the Level **Modeling-Limits of Construction**.

10) Select the **Task > Civil Tools > Terrain Model > Change Feature Type** tool and choose the **Boundary** Option.

11) Open **Terrain_Proposed_J9P3093.dgn**

12) Delete all elements in file.

13) Reference in the **Corridors_J9P3093.dgn**, **3D** view.
   a. Fit the view.

14) In the Level Display dialog turn off all level except for **Modeling-Terrain-Proposed** and **Modeling-Triangles-Proposed**.
   a. If the **Corridors_J9P3093.dgn**, 2**D** view was automatically referenced in turn off the display.

15) In the **Reference Dialog** select the **Corridors_J9P3093.dgn**, **3D** view reference and select Merge into Master.

16) After elements have been merged, **detach** both references.

17) The element that has been merged is a terrain model but does not have the correct Feature Definition settings to be a full Civil Terrain Model. To verify this select the terrain and choose **Properties** from the heads up tool. You should notice that there is no Feature Definition applied.

18) To apply a feature definition to the Terrain Elements select **Task > Civil Tools > General Geometry > Set Feature Definition**

Feature Type:	Surface
Feature Definition:	Design Triangles
Name:	Design Triangles from Linear Features

19) Select **Task > Civil Tools > Terrain Model > Edit Terrain Model** tool.
   a.   Try and edit the Terrain model

20) Open **Corridors_J9P3093.dgn**

21) In the 3D view delete the Terrain Model that was created from the Linear Elements.

22) Select the "**F6**" key to bring both the **2D** and **3D** view back.

Note:

- If your bottoms of ditches are not showing up as a linear element open the properties of the Feature Definition XS Ground Proposed and turn on the option for **Create Template Geometry.** Once turned ON the User will need to reprocess the corridor to see the linear elements.